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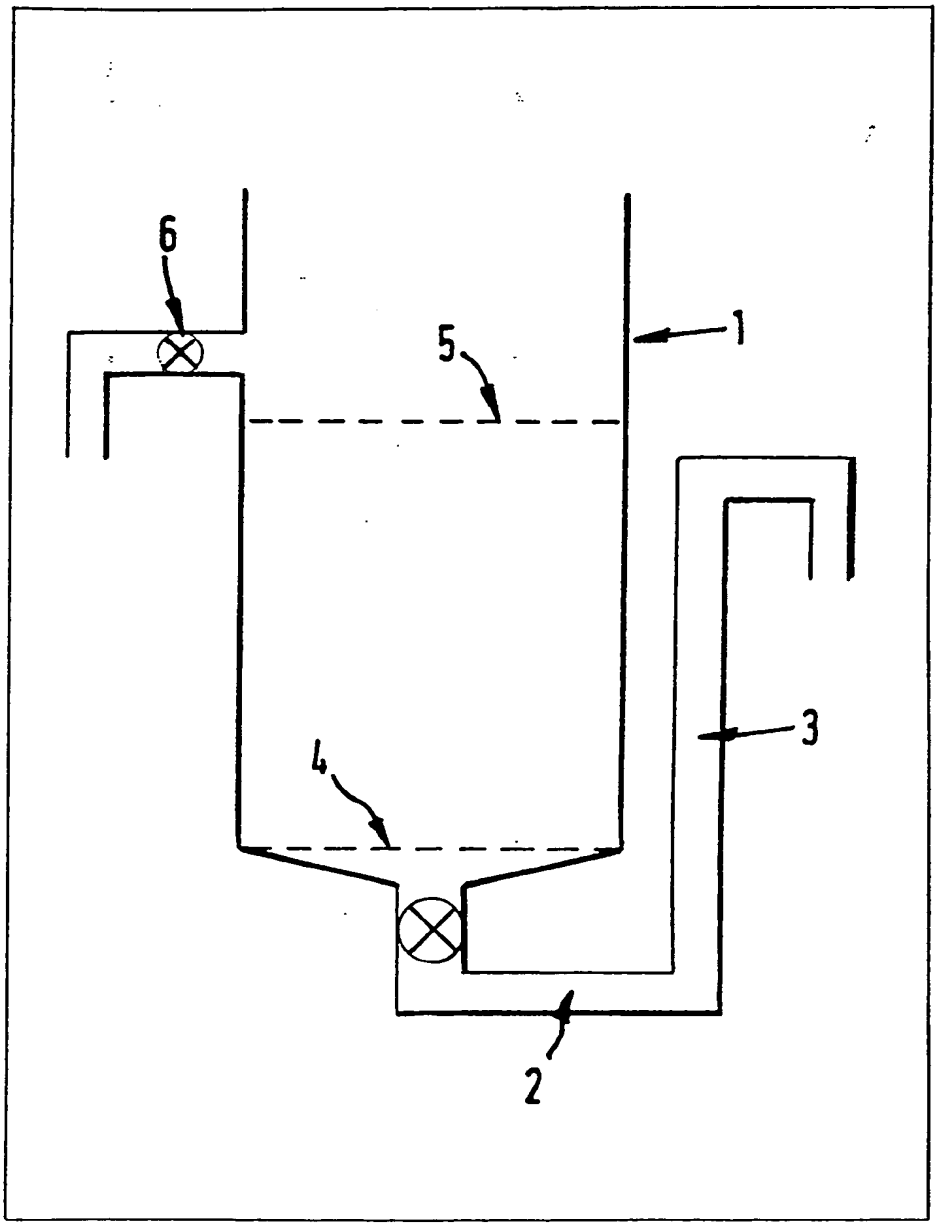
(54) **Method and apparatus for removing organic liquids from aqueous media**

(57) Organic liquids and/or dissolved coloured materials are removed from water by passing it downwards through a packed bed of pieces of foamed polyurethane and/or polystyrene between grids 4 and 5. The foamed material may be regenerated when saturated by squeezing or centrifuging. Organic liquid tends to accumulate upstream of the bed and can be periodically drawn off through valve 6.



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SPECIFICATION

Method and apparatus for removing organic liquids from aqueous media

The present invention is concerned with a method and apparatus for the removal of water-immiscible or substantialy water-immiscible organic liquids from aqueous media.

Many industrial effluents and process waters contain small quantities of water-immiscible or substantially water-immiscible organic liquids which are expensive to lose and/or are expensive to treat or to remove before the water can be discharged.

Quite apart from obviating potential environmental hazards, it would be clearly advantageous to remove organic liquids from aqueous media if such organic liquids can be re-used and especially when such organic liquids are expensive. Furthermore, process waters frequently become contaminated with coloured materials which, although themselves not constituting an environmental hazard, limit or even prevent such process waters from being recycled.

Consequently, there is a need for a method and apparatus which can be used for the separation of water-immiscible and substantially water-immiscible organic liquids from aqueous media.

It is known that several synthetic resins are oleophilic and, in the presence of mixtures of oils and water, tend to attract oil to a greater extent than water.

We have now found that such oleophilic properties are not only possessed to an outstanding degree by foamed or expanded polyurethanes and polystyrenes but that they also display a great affinity for other water-immiscible or substantially water-immiscible organic liquids and, in addition, possess the ability to remove dissolved colourless materials from aqueous media.

Thus, according to the present invention, there is provided a, method of removing water-immiscible and substantially water-immiscible organic liquids and/or dissolved coloured materials from an aqueous medium containing them, wherein the aqueous medium is passed through foamed and/or expanded polyurethane and/or polystyrene.

The present invention also provides an apparatus for removing water-immiscible or substantially water-immiscible organic liqiuds and/or dissolved coloured materials from aqueous media, said apparatus comprising a vessel provided with an inlet and an outlet, said vessel containing a foamed and/or expanded polyurethane and/or polystyrene.

The foamed or expanded polyurethane and/or polystyrene used according to the present invention can be in the form of irregularly shaped pieces or of uniformly shaped pieces, such as cubes, spheres, sheets or strips. Furthermore, use can also be made of simple or multiple layer sandwiches of foamed or expanded polyurethane and/or polystyrene.

According to a preferred embodiment of the present invention, the foamed or expanded material is packed into a column of appropriate dimensions provided with an inlet and an outlet. The inlet is preferably at the top of the column and the bottom outlet preferably leads into a tube which rises up outside of the column to a level at least half way up the height of the column. For reasons explained hereinafter in more detail, the upper half of the column is preferably also provided with a run-off valve or stopcock.

The column is packed with foamed or expanded polyurethane and/or polystyrene. Alternatively, the column can contain a plurality of perforated trays containing foamed or expanded polyurethane and/or polystyrene sandwiched between sheets of foamed or expanded polyurethane and/or polystyrene.

When the foamed or expanded material is used in particulate form, it is preferable to guard the outlet of the column with an appropriate grid in order to prevent ingress of the material into the outlet.

The foamed or expanded material is then preferably lightly constrained from above by a second appropriate grid in order to prevent the material from floating when the column is filled with liquid.

Prior to use, the packed column is filled with water and air is expelled by the application of pressure to the foamed or expanded material. When the column is provided with the above-mentioned second grid, this can be adapted to slide up and down in the column and can be provided with appropriate means for fixing this second grid in any desired position. In the case of this embodiment, air can readily be expelled by flooding the column with water, applying a downward pressure on the second grid and then fixing the second grid in any desired position, care being taken that the amount of pressure applied to the foamed or expanded material is not so great that the material is compressed to such an extent that the flowthrough of aqueous media is unduly retarded.

We have found that the method and apparatus of the present invention is outstandingly useful for the removal or separation of vegetable and mineral oils and of other water-immiscible and substantially water-immiscible organic liquids from aqueous media.

The absorbed organic liquids can be easily recovered from the foamed or expanded material, for example by pressing or centrifuging the material after removal from the column containing it.

However, we have also found that after the apparatus has been in operation for some time, the separated organic liquids tend to accumulate at the top of the column and can, therefore, be bled off through a valve or stopcock provided in the upper part of the column. Since, when this stage is reached, the ability of the foamed or expanded material to separate organic liquids from aqueous media is not impaired, this means that the column can be operated for long periods of time without having to remove

and regenerate the foamed or expanded material. Obviously, if it is desired to recover and reuse the separated organic liquids, then it will be necessary to remove and regenerate or replace the foamed or expanded material when there is to be a change of the aqueous feed.

In the course of a series of experiments using an aqueous feed containing liquid paraffin, we have found that up to 90% of the paraffin is removed and can be recovered.

We have also found that when aqueous media are treated which contain dissolved coloured materials, then the coloured materials are also removed by the foamed or expanded material. After some time, which depends upon the amount of dissolved coloured materials present in the aqueous feed, coloured materials are again found in the run-off. However, the foamed or expanded materials can easily be regenerated and the colour-removing capacity restored simply by soaking in clean water, followed by squeezing. Although the foamed or expanded material is, after regeneration, sometimes still coloured, aqueous media subsequently passed therethrough do not remove the coloured material and any coloured materials present therein are removed therefrom.

Examples of organic liquids which have been satisfactorily removed from aqueous media by means of the method and apparatus according to the present invention include liquid paraffin, white spirit, soya bean oil, linseed oil, olive oil and cod liver oil.

The following Example is given for the purpose of illustrating the present invention, reference being made to the accompanying drawing which illustrates one embodiment of the apparatus according to the present invention.

EXAMPLE

A cylinder (1) of 62 mm. diameter and 200 mm. height was fitted with a bottom outlet (2). A tube (3) attached to the bottom outlet ascended outside the cylinder to a level 150 mm. from the base thereof.

The cylinder (1) was packed with irregularly shaped pieces of polyurethane foam with sizes from approximately 10 mm. x 10 mm. x 10 mm. to 2.5 mm. x 2.5 mm. x 2.5 mm., the pieces having been obtained by tearing them from a bulk quantity of the foamed material. The outlet from the cylinder was guarded by a grill (4) and the cylinder was packed with the pieces of foam up to a level of about 150 mm. The pieces were then lightly constrained from above by a metal grill (5) to ensure that they did not float when the cylinder was filled with liquid. Air was removed from the foamed material by flooding the cylinder with water and applying a slight downward pressure to the foamed materials while it was immersed in water.

Water containing 500 ppm of liquid paraffin was now fed to the top of the column at a rate of 250 ml./minute. The water discharging from the column was found to contain only about 50 ppm of liquid paraffin, the actual concentration of liquid paraffin in the discharged water depending on the rate of flow. Similar results were obtained when using foamed polystyrene in the form of pearls of 2 to 5 mm. diameter.

After a long period of operation, liquid paraffin tended to accumulate at the top of the column and could be bled off through an appropriately positioned valve (6).

Further experiments have shown that a column containing a plurality of perforated trays with foamed polystyrene sandwiched between sheets of polyurethane foam also effectively removes and concentrates oil. Furthermore, massive blocks of foamed or expanded polyurethane or polystyrene are equally effective.

Experiments have shown that the capacity of the stationary phase is high and, in the case of foamed polyurethane, is of the order of 25% of the expanded volume.

The details and results of two runs for removing liquid paraffin from water using a column packed with foamed polyurethane are given in the following Table. The column used had a total plan area of 0.0177 m^2, a packed depth of 0.3 m., a diameter of 0.15 m. and a total volume of 0.0053 m^2.

TABLE

Run No.	Duration (hrs)	Depth/ diam.	Hydraulic load $m^3/m^3/hr.$	Surface load $m^3/m^2/hr.$	Paraffin conc. in feed mg/l.	Paraffin conc. in run-off mg/l.	% removal
1	187	2	1.02	0.31	1817	197	89
2	240	2	2.49	0.75	2018	170	92

CLAIMS

1. A method of removing water-immiscible and substantially water-immiscible organic liquids and/or dissolved coloured materials from an aqueous medium containing them, wherein the aqueous medium is passed through foamed and/or expanded polyurethane and/or polystyrene.,

2. A method according to claim 1, wherein the foamed and/or expanded polyurethane and/or polystyrene is in the form of irregularly shaped pieces.

3. A method according to claim 1, wherein the foamed and/or expanded polyurethane and/or polystyrene is in the form of uniformly shaped pieces.

4. A method according to claim 1, wherein simple or multiple layer sandwiches of foamed and/or expanded polyurethane and/or polystyrene are used.

5. A method according to claim 1, wherein there is used a plurality of perforated trays containing foamed and/or expanded polyurethane and/or polystyrene sandwiched between sheets of foamed and/or expanded polyurethane and/or polystyrene.

6. A method according to any of the preceding claims, wherein absorbed organic liquid is recovered by pressing or centrifuging the foamed and/or expanded polyurethane and/or polystyrene.

7. A method according to claim 1 of removing water-immiscible and substantially water-immiscible organic liquids and/or dissolved coloured materials from an aqueous medium, substantially as hereinbefore described and exemplified.

8. Apparatus for removing water-immiscible and substantially water-immiscible organic liquids and/or dissolved coloured materials from aqueous media, said apparatus comprising a vessel provided with an inlet and and outlet, said vessel containing foamed and/or expanded polyurethane and/or polystyrene.

9. Apparatus according to claim 8, wherein the outlet is provided at the bottom of the vessel, which is in the form of a column, said outlet rising up outside the column to a level at least half way up the height of the column.

10. Apparatus according to claim 8 or 9, wherein the upper part of the vessel is provided with a run-off or stopcock.

11. Apparatus according to any of claims 8 to 10, wherein the outlet is provided with a grid to prevent ingress of material into the outlet.

12. Apparatus according to any of claims 8 to 11, wherein the vessel is provided with a grid for constraining the foamed and/or expanded polyurethane and/or polystyrene, said grid being adapted to slide up and down and being provided with means for fixing it in any desired position.

13. Apparatus according to any of claims 8 to 12, wherein the vessel contains a plurality of perforated trays containing foamed and/or expanded polyurethane and/or polystyrene sandwiched between sheets of foamed and/or expanded polyurethane and/or polystyrene.

14. Apparatus according to claim 8 for removing water-immiscible and substantially water-immiscible organic liquids and/or dissolved coloured materials from aqueous media, substantially as hereinbefore described and exemplified and with reference to the accompanying drawing.

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